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1964 No. 1

Plaice Investigations in Scottish Waters

1. Size-Composition of the Stocks 1910-1952

By J. M. LAMONT
Marine Laboratory, Aberdeen
June, 1963

EDINBURGH: HER MAJESTY'S STATIONERY OFFICE

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Plaice Investigations in Scottish Waters

INTRODUCTION

The plaice, *Pleuronectes platessa L.*, is widely distributed in the North Sea, but, being chiefly a shallow-ater species, its main concentrations are in the southern and south-eastern parts. Although appearing inly over a wide area of the northern North Sea it is mainly confined, in this region, to a relatively arrow, coastal zone, 30 to 90 miles wide, extending from Berwick to the north of Shetland and lying tirely to the west of the Greenwich meridian. In this zone adult plaice are found chiefly outside rritorial waters, while immature and adolescent fish inhabit the sandy bays and other shallow waters. pawning takes place in the first quarter of the year, mainly in water varying in depth from 20 to 40 thoms, and Bowman (1914, 1921) has demonstrated the existence of certain favoured spawning areas.

Plaice are also caught off the north and west coasts of Scotland wherever suitable conditions occur, ut such areas are limited in extent and are in no way comparable in importance with the two main eas on the east coast, the East Scottish Bight and the Moray Firth, which together provide more than alf the Scottish plaice landings. Limited spawning also takes place in various localities off the north nd west coasts of the county of Sutherland, in the Skerryvore region, off Islay, in the Firth of Clyde and en as far west as St. Kilda. On all coasts the plaice spawning grounds are adjacent to sandy bays which ovide the necessary nursery conditions for the young fish when they take to life on the sea floor.

THE IMPORTANCE OF THE PLAICE IN SCOTTISH FISHERIES

Some indication of the importance of the plaice to Scottish fisheries may be obtained from the arly landings given in the statistical tables published by the Fishery Board for Scotland, later by the cottish Home Department and now by the Department of Agriculture and Fisheries for Scotland. hese show that the plaice is the commonest flatfish in Scottish waters. Landings of plaice in Scotland ve increased since the end of the second world war, so that the species has risen from eighth to fourth sition in order of importance as regards weight of individual species of white fish. In total value the e has been from fifth to fourth position and in average value per unit of weight the species throughout e years has continued to rank either sixth or seventh on the Scottish market.

Further analysis of the landings also shows that 81% of the total weight of plaice landed in Scotland om all fishing regions since 1922, when Scottish fishery statistics first indicated the regions from which h were landed, came from the North Sea (south of 62°N and east of 4°W), 14% from west of Scotland ounds (west of 4°W), 1% from Faroe, 2·3% from Iceland and the remaining 1·7% from various mixed d unknown grounds including small quantities from the Barents Sea. That 95% (range 87 to 98% arly) of the landings of plaice should be caught in home waters is evidence of the importance of this ecies to Scottish fishermen.

Table I gives the total landings of plaice in Scotland by British vessels from all fishing grounds om 1904 to 1961 and also shows the quantities obtained by the different fishing methods. In addition showing the increase in plaice landings in the last 13 years Table I and Figure 1 derived from it reveal ctuations of considerable magnitude in the landings over the whole period from 1904. Although the estion of variations in the brood strengths will be considered later there is no doubt that the major ctuations in plaice landings are associated with certain historical events during the period.

From 1904 to 1914 landings declined. This decline is rather surprising since otter trawling was veloped in Scotland during this decade and one might have expected increased landings. The planation would appear to be that as stocks of all kinds of fish were gradually reduced on the nearer ottish grounds vessels were forced to fish on more distant grounds where plaice are less abundant.

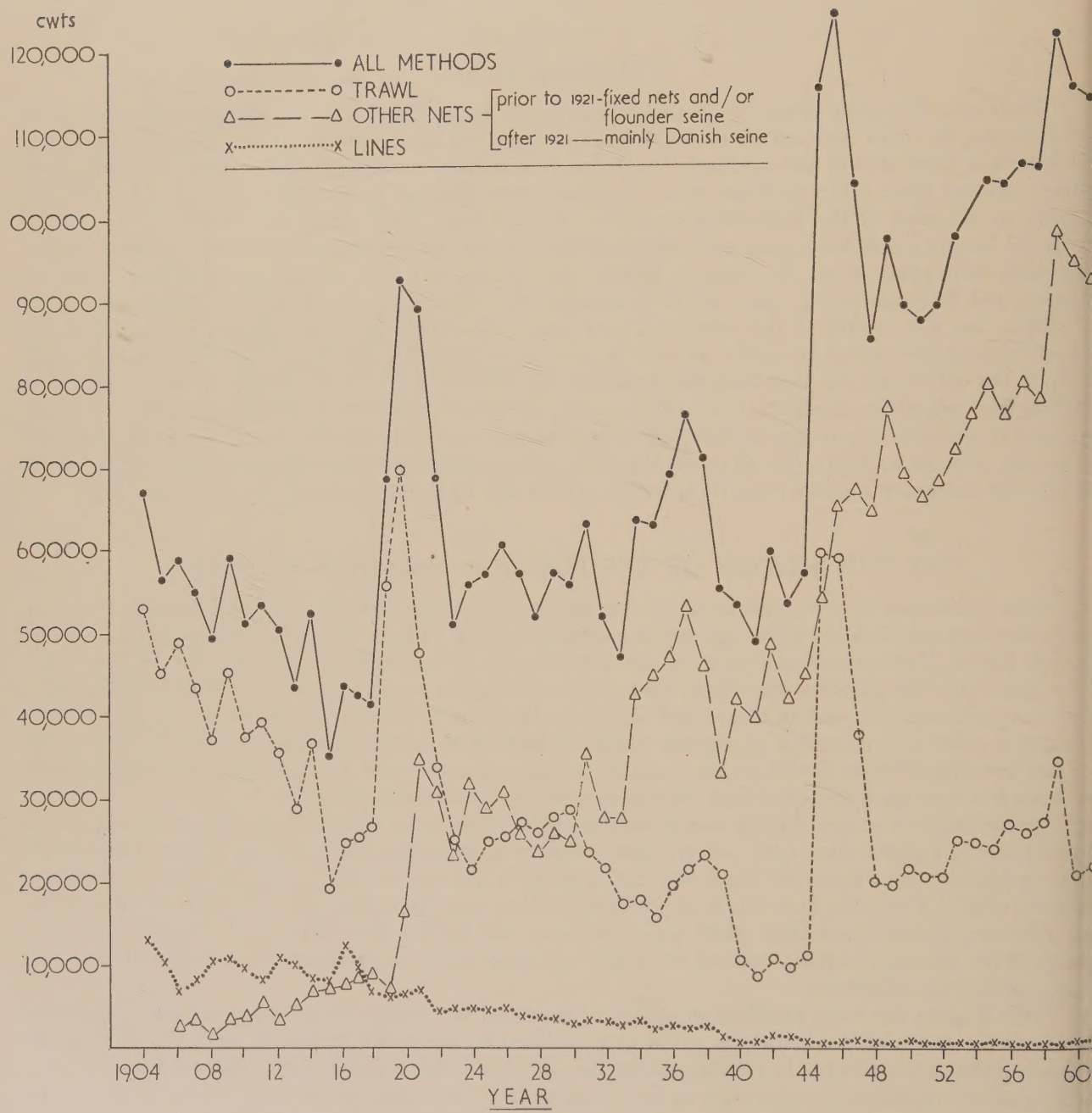

Fig. 1. Plaice landings (in cwt) in Scotland by British vessels from all areas.

During this period the bulk of the plaice was caught by trawl; an appreciable and fairly steady amount was accounted for by small-lines and a small but increasing quantity by set-nets and by flounder seine.

During the 1914-1918 war landings reached their lowest level of the whole period. With the return of fishermen and their vessels from war service plaice landings like those of other species rose rapidly in 1919, reaching a peak in the following two years. This resulted mainly from trawling but a sudden increase in the quantity of plaice taken by other nets in 1921 was attributable to the accumulation of fish on the grounds after the war and to the introduction of the Danish seine in Scotland, particularly in the Moray Firth, where, owing to the prohibition of trawling, plaice stocks had hitherto been underfished. Figure 1 also demonstrates the beginning of the decline in small-line fishing at the end of the first great war. After the reduction of the stocks accumulated during the war, plaice landings by trawl in 1923 fell to the same level as those by the Danish seine and other nets and for eight years landings by the two methods were approximately equal. With the increasing use of the seine-net in the Moray Firth and its adoption on other sections of the Scottish coast, seine-net landings of plaice began to rise, while those by trawl declined (Ritchie, 1960). These trends continued until 1938. The outbreak of the second great war resulted in a fall in the total plaice landings. This was mainly in consequence of the departure of trawlers to war service.

The accumulation of fish stocks during the second war, as during the first war, again resulted in exceptionally large landings of plaice, which reached a peak in 1945 and 1946. Although seine-net catches had continued to rise steadily from 1943 onwards the extraordinary quantities of plaice landed first after the war were largely from trawlers, which, for a short period, caught up with the seiners in their ability to catch plaice. From 1946 onwards, however, trawler catches declined rapidly and from 1948 to the present time have remained steady at about 20% of the total plaice landings. Meanwhile, seine-net landings continued to rise. After reaching a peak in 1949 they declined for two years, but since 1951 their general trend has been upwards and in 1959 the quality of plaice caught by seine-net reached an all time maximum of 97,000 cwt.

Although the yearly landings of plaice in Table I and Figure 1 include all fishing regions, landings from the North Sea and west of Scotland grounds, which together provide 95% of the total, closely reflect each change in the yearly total from 1922 onwards. It is not unreasonable, therefore, to regard the yearly totals as representative of plaice landings in Scotland from home waters.

PREVIOUS INVESTIGATIONS

In view of the ease with which the plaice can be caught, its economic importance in Scottish fisheries, and its vitality and general suitability in experimental work, it has been the subject of considerable research by Scottish fishery scientists. Towards the end of the 19th century various investigators studied different aspects of the biology of the principal food fishes in Scottish waters. In the course of this work much attention was given to the distribution of the eggs and larvae of plaice (McIntosh, 1890; Masterman, 1897; Kyle, 1898), while Dannevig (1897) studied the experimental rearing of the larval and post-larval stages. Numerous references to the growth of plaice occur in the scientific investigations of the Fishery Board for Scotland; for example, Fulton (1893), Masterman (1895), Dannevig (1899) and others.

The marking or tagging of plaice has been a feature of Scottish fishery investigations since it was instituted in 1889 (Fulton 1893). Fulton's (1919) later work in this field was extended to other sections of the Scottish coast by Bowman (1933). Bowman (1914, 1921) also dealt with the spawning of plaice and the distribution of their eggs in the northern North Sea and Ritchie (1938) studied the food of the species in Scottish waters.

Garstang (1909) and Thompson (1913) were concerned mainly with the composition of the plaice stocks off the Scottish east coast during the first decade of the 20th century. From that time onwards investigations were continued every year, with the exception of the periods of the two wars, until 1952. Some of the results of this work have already been referred to in the annual reports of the Fishery Board for Scotland and latterly of the Scottish Home Department. Following the first war, under the direction of Dr Bowman, attention was mainly focussed on the plaice nursery grounds of the Scottish east coast.

This was to some extent stimulated by the need for regular surveying of inshore plaice stocks in order to study developments arising from the effect on the stocks of the various bylaws permitting seine netting within the territorial waters by small vessels.

SCOPE OF THE PRESENT INVESTIGATIONS

Considerable changes and development occurred in fishery practice in the Scottish area, both inside and outside territorial waters, in the period 1910-1952. Prior to 1921 the plaice population in the area, particularly in territorial waters, was to a large extent a protected stock, only moderately exploited by sail boats fishing with lines and, on certain sectors, by flounder-seine or circle net; extra-territorially on the nearer offshore grounds, restrictions on trawling, either wholly as in the Firth of Forth or partially as in the Moray Firth, served to maintain its semi-virgin nature. After 1921 the introduction and expansion of the Danish seine-net method of fishing in Scottish waters, the gradual changeover from sail to mechanically-propelled inshore craft, the limited opening of additional areas to fishing by small vessels and the general increase in the intensity of fishing all contributed to bringing about marked changes in the composition of the plaice stocks throughout the area.

This report is concerned mainly with a study of these changes as they were revealed by experimental trawling surveys. The investigations were not continuous; no material was collected during the two wars and unavoidable gaps occurred at other times. They also varied in scope and intensity, according to the importance of particular fishery areas at particular times, and in uniformity, through the necessity to employ different research vessels. Despite their deficiencies the results add considerably to our knowledge of the plaice and serve to demonstrate the changing characteristics of Scottish inshore plaice communities.

As it is intended to provide a general picture rather than an exhaustive study, the results have been condensed considerably in this review. The whole material may be consulted at the Marine Laboratory, Aberdeen.

THE AREA INVESTIGATED

The principal area investigated is shown in Figure 2. It comprises the nursery grounds of the various bays of the Scottish east coast from the Moray Firth to the Firth of Forth, and the adjacent offshore grounds from the Moray Firth southwards to the neighbourhood of Aberdeen. Offshore grounds south of Aberdeen, though also plaice grounds, were not investigated in a comparable manner.

Off the Scottish east coast the 20 fathom contour coincides closely with the territorial limit and the 30 fathom contour runs more or less parallel to it except in the north-western Moray Firth and east of the Firths of Forth and Tay, where its distance from the coast varies from 10 to 35 miles. The nature of the bottom varies considerably, consisting of pure sand in the bays, sand with a mixture of mud and rocky patches elsewhere within the territorial zone, and mud in the deeper central portions of the Moray Firth and Firth of Forth.

The Moray Firth is the most important plaice spawning ground in the northern North Sea, while some spawning also takes place off the Aberdeenshire coast and off the Firths of Forth and Tay (Bowman, 1914, 1921). It is probable that the area receives adult plaice from the southern North Sea (Borley, 1916; Carruthers, 1924; Clark, 1947) but Scottish tagging experiments (Fulton, 1920, and unpublished) and Bowman's investigations indicate that the plaice stock in the area is largely self-supporting; adult fish move in a northerly direction to spawn, while a compensatory southerly movement of the coastal waters carries eggs and larvae to the nursery grounds.

The area is also rich in other species, notably cod, haddock, whiting and lemon sole. Although some of these species are of greater importance economically, the plaice, owing to its vulnerability within territorial waters has necessarily received more legislative protection. Many measures have been passed over the years to ensure maximum protection consistent with fishing developments and in relation to the economic and social requirements of the numerous small fishing communities along the coast.

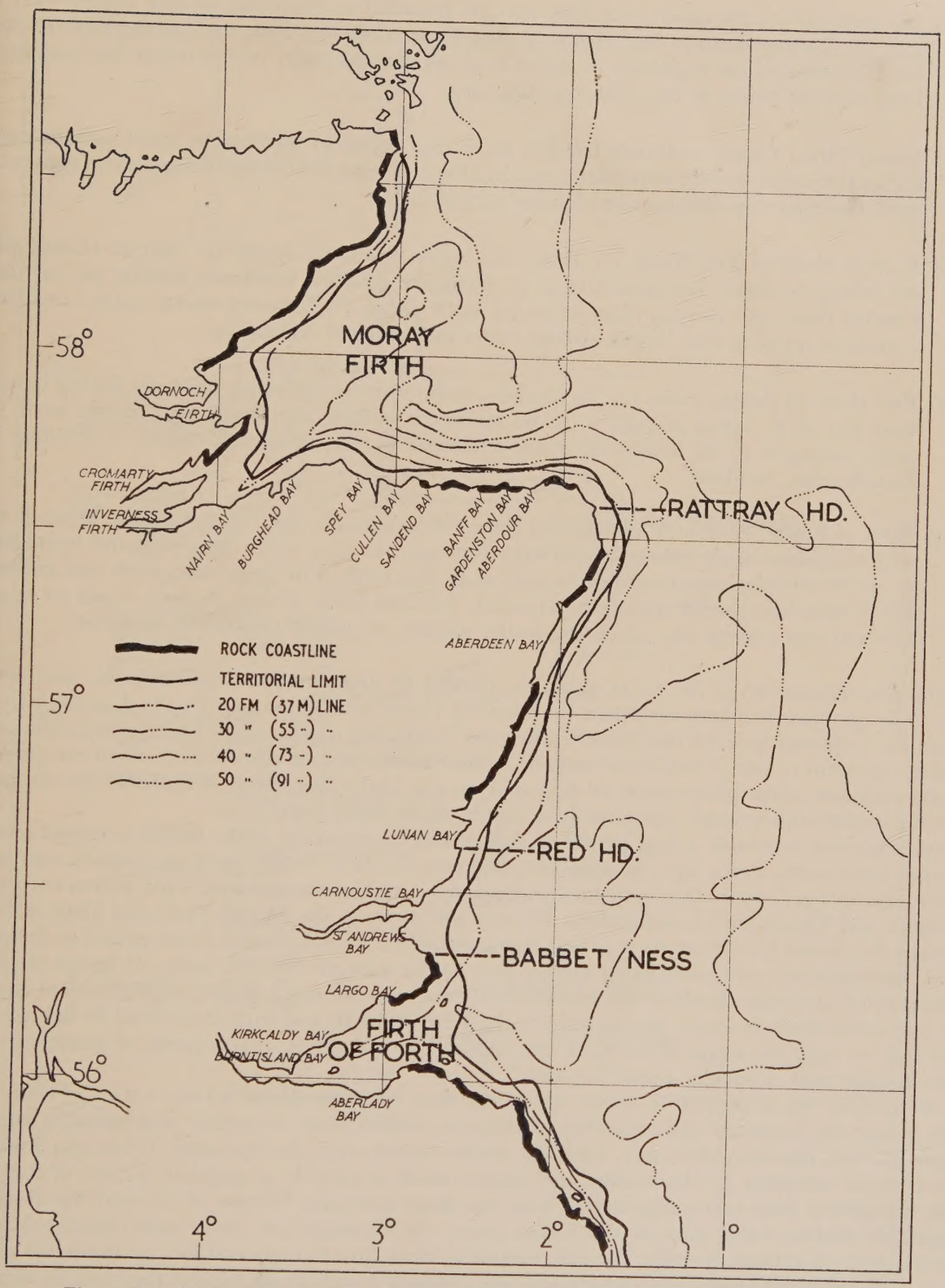

Fig. 2. Scottish East Coast, fishery regions: Moray Firth; Rattray Head to Red Head; Red Head to Babbet Ness; Firth of Forth.

For the purposes of this report, the area may be regarded as consisting of four regions—(1) the Moray Firth, (2) Rattray Head to Red Head, (3) Red Head to Babbet Ness, and (4) the Firth of Forth (see Fig. 2). Discussion of the legislative measures in detail is unnecessary in this report but attention is drawn to the relevant points in the following summary.

(1) Moray Firth: Closed to British trawlers since 1892; open to trawling by other nations except within territorial waters; territorial zone also closed to seine-net fishing; international convention mesh and minimum landing size of plaice operative.

(2) Rattray Head to Red Head: (*a*) Territorial waters: partially opened in 1921 to Danish seine-net fishing by vessels not exceeding 40 ft; mesh size 4 inches, minimum landing size for plaice 8 inches from 1921 to 1929 when increased to 10 inches. (*b*) Extra-territorial waters: unaffected —open to trawling and Danish seining under international regulations.

(3) Red Head to Babbet Ness: (*a*) Territorial waters: opened to Danish seine net fishing in 1921: boat size 40 ft, raised in 1937 to 50 ft; minimum landing size for plaice 8 inches until 1937 when increased to 10 inches. (*b*) Extra-territorial waters: unaffected—open to trawling and Danish seine, as above.

(4) Firth of Forth: Closed to all trawling since 1886; partially opened to flounder seine in 1905 with extensions (applicable to Danish seine from 1921) in 1914, 1916, 1929, 1936 and 1950 leading to almost complete opening in three sections to that method in 1955; boat, mesh and minimum plaice sizes have varied with each extension, the final limits of these being:—vessel 50 ft, mesh size 100 mm and 70 mm according to the section; minimum plaice size 10 inches.

The size-composition of the plaice stocks as revealed by experimental trawling in the area outside the 5–10 fm contours has been described by Garstang (1909) and Thompson (1913). Garstang treated his data on a regional basis for comparison with other North Sea regions while Thompson demonstrated the wide variations in size at individual stations. Nevertheless both sets of results reveal an exceptionally high size structure of the plaice stocks in these early years. Little information is available for this period about the smaller and younger fish inhabiting depths of less than 5 fm.

Investigations over such a long period of change and development in the fishery necessarily varied in nature and extent. From 1910 to 1922 (a comparatively static period until the introduction of the Danish seine in 1921) their scope remained comparatively stable compared with the period covered by Garstang's and Thompson's investigations. Priority was given to the Moray Firth and Firth of Forth. Although the period from 1923 to 1930 was characterised by a considerable development in the plaice fishery, investigations were made along similar lines but by a larger research vessel. Although the larger vessel operated at similar depths it was less frequently available for plaice surveys. Continuity of observations was maintained, however, particularly in the Firth of Forth and from Red Head to Babbet Ness. From 1931 to 1952 the scope of the work was widened to include the investigation of shallower water by the employment of smaller research vessels.

At no time was it possible to utilise any of the ships solely for plaice survey work and over much of the period the frequency and regularity of sampling varied. More systematic and intensive sampling became possible, however, after 1931, when the smaller vessels came into operation. It was also impossible to synchronise sampling by the smaller and larger vessels to provide a complete picture of the plaice stocks throughout their entire distribution from the shore seawards. Because of this and the absence of comparable shallow-water data in the earlier years, the investigations have been considered in two separate, partly-overlapping series. The first, extending from 1910 to 1939, and to 1952 in certain regions, was carried out by the two larger vessels and was concerned with stocks outside the 5–10 fm contours. In the second, from 1931 to 1952, the smaller vessels were concerned for the most part with the population within the 5–10 fm contours.

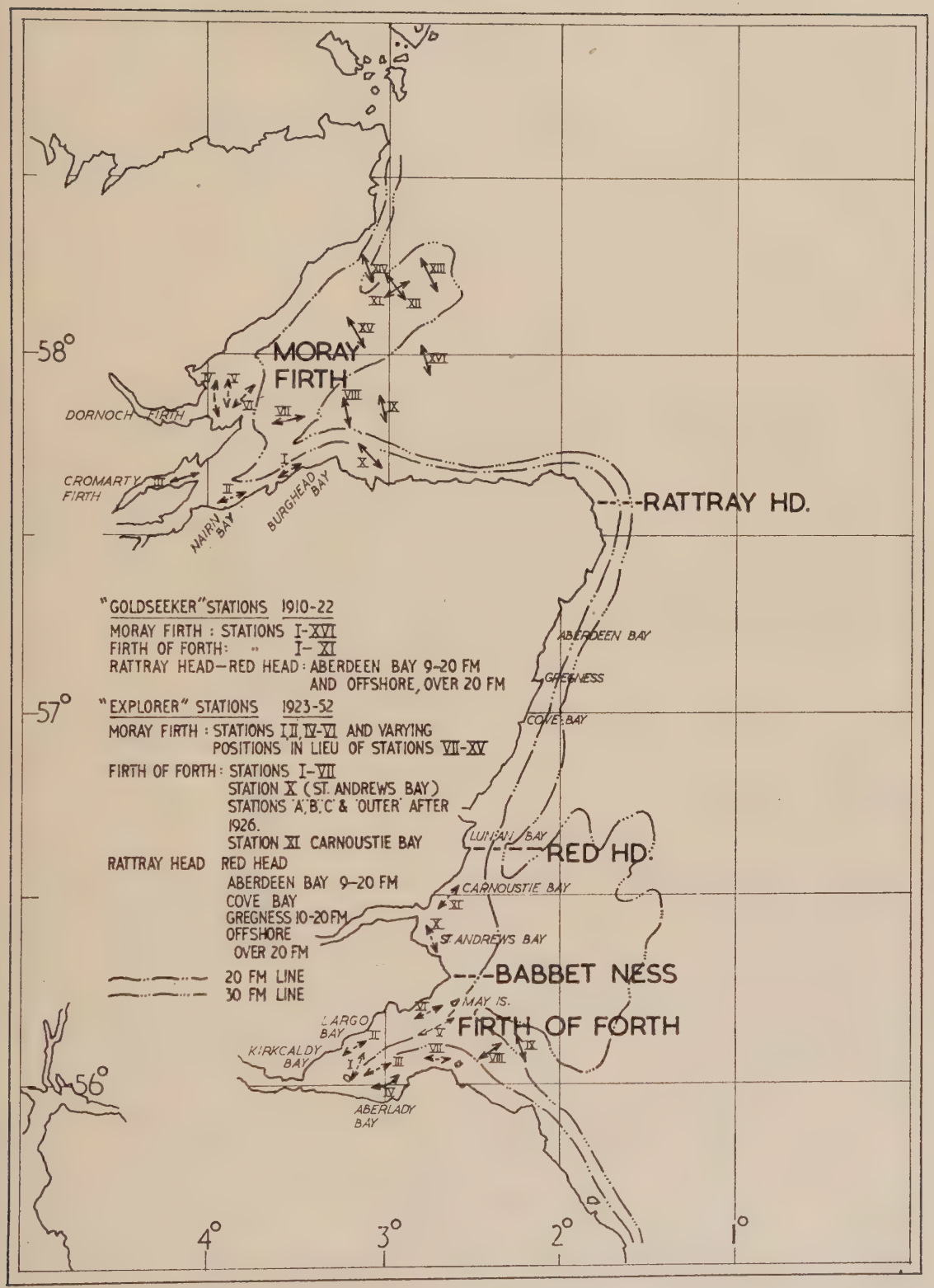

Fig. 3. Scottish East Coast, *Goldseeker–Explorer* trawling stations.

The two series are referred to as Series (1) *Goldseeker–Explorer* and Series (2) *Enid–Kathleen*. The sampling positions of Series (1) are shown in Figure 3 and of Series (2) in Figure 4. Few of the stations in the former series were laid down in accordance with depth zoning but the *Enid–Kathleen* Series sampling was planned by depth zones; two zones in the *Enid* surveys (<5 fm; 5–10 fm) and four zones in the *Kathleen* surveys (2–5 fm; 5–10 fm; 10–15 fm; 15–20 fm, or 15–26 fm in the Firth of Forth). In this series, also, as many stations as possible were sampled in order to obtain maximum representative material, the number varying according to the size of the area, ranging from two to four in the smaller bays to eight to sixteen in the larger bays such as Dornoch Firth, Aberdeen Bay and St Andrew's Bay.

The gear used throughout was the otter trawl with small mesh covering over the codend but the type and dimensions of the nets differed materially in the two series to match the power of the vessels. The duration of the trawl hauls varied according to circumstances but as far as possible the results have been given in a comparable form.

THE MATERIAL AND ITS TREATMENT

The information collected (Tables II-V) consists of the length measurement of over 500,000 plaice, taken in some 3,000 hauls in approximately 3,000 hours' fishing. In most samples the sexes of plaice over 10 cm in length were distinguished and the maturities noted. In this review, the sexes have been combined but the maturity data have not been dealt with. A thorough investigation of the age-composition of the stocks began in 1920, since when the otoliths of about 300,000 plaice have been examined.

In view of the large quantity of material available and of the many variables in its collection, an absolutely quantitative evaluation of the results has not been possible. However, the method of assessment of changes in the size composition of the stocks, based on relative percentage proportions, is regarded as satisfactory. Another consideration is that of depth. The importance of this factor in the sampling of plaice in their characteristic size-age-depth distribution need not be emphasised to those engaged in similar investigations. Accordingly the depth zones in the two series are considered under the following groupings:

	Goldseeker–Explorer	*Enid*	*Kathleen*
	1910–1952	1931–35	1937–52
Moray Firth	6–15 fm; 20–50 fm	2–10 fm	2–10 fm; 10–20 fm
Rattray Head–Red Head ..	9–20 fm; 20–50 fm	,,	,, ,,
Red Head–Babbet Ness (St Andrew's Bay)	6–11 fm; 11–20 fm	2–11 fm	2–10 fm; 11–20 fm
Firth of Forth	10–26 fm	2–10 fm	10–26 fm

The material is insufficient from all regions to allow annual changes in size to be followed. It has, therefore, been combined into such periods as will permit the most profitable study of the changes that occurred during the main phases of the fishery. Although these phases varied from region to region and even within the same region during the period, certain factors were common to all—the general static fishing conditions characterising the period prior to and immediately after World War I, a developmental stage from 1921 to 1930, an established phase from 1931 to 1939, and conditions following World War II. The periods which have been adopted relative to these main phases and their experimental examination are as follows:

1910–14	pre-war I conditions	*Goldseeker–Explorer* records
1919–20	immediate post-war I conditions and before the introduction of the Danish seine	
1921–25	development of the Danish seine-net fishery	
1926–30		
1931–35	establishment of Danish seine and pre-war II conditions	*Explorer* and *Enid–Kathleen* records
1936–39		
1946–50	post-war II conditions to 1952	
1951–52		

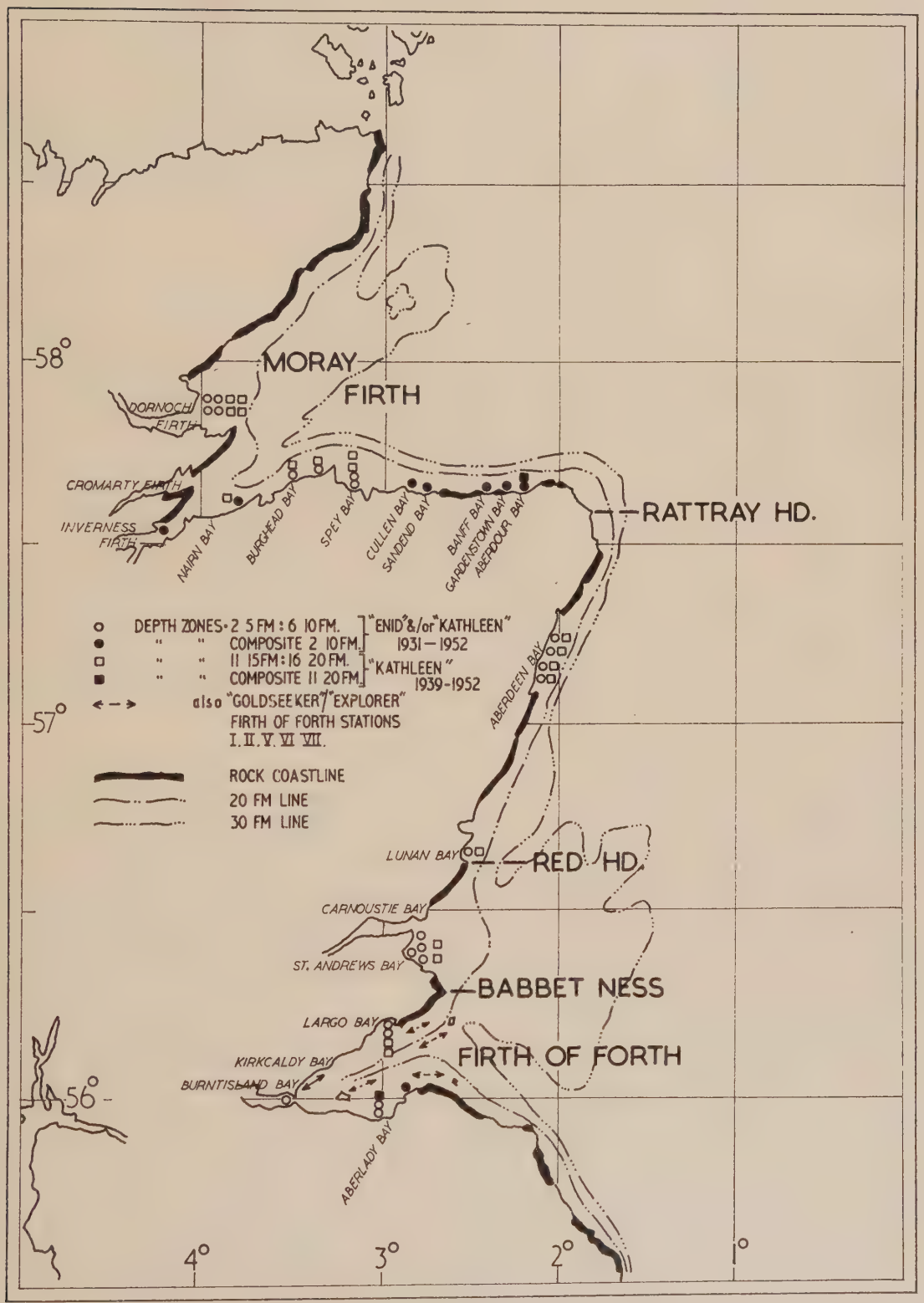

Fig. 4. Scottish East Coast, *Enid–Kathleen* trawling stations.

As indices of size changes, only the marketable sizes of the populations are considered and analysed here. These are expressed as percentages of the total populations, as sampled, at and above certain given sizes and are given in Tables II-V and illustrated in Figures 5-8. The sizes below the marketable minimum (25 cm or 10 inches), although of importance and interest both in their changing relative abundance and composition, are not examined; their percentage proportions are given in the tables but are excluded from the illustrations. The sizes selected are those which most readily convey the picture of the changing size-structure. These sizes are: 25 cm (10 in.), below which all plaice are now generally regarded as undersized, 35 cm ($13\frac{3}{4}$ in.), the approximate maturing size in Scottish waters, and large and extra-large fish >45 cm (>18 in.) and >60 cm (>24 in.).

CHANGES IN SIZE COMPOSITION

The Moray Firth (Table II, Figure 5)

In this region the densely populated, shallow water grounds of the Dornoch Firth, Burghead Bay and, to a less extent, Nairn Bay, were given most attention; 155,502 measurements of the Moray Firth total (202,543) are from these inner firth grounds. The size composition is similar in all three localities and the measurements have, therefore, been combined. The records are as follows:

Goldseeker–Explorer	6–15 fm 1910–52	53,813 measurements
Enid–Kathleen	2–10 fm 1931–35; 1937–52	70,806 ,,
Kathleen	10–20 fm 1937–52	30,883 ,,

Some 5,000 *Goldseeker–Explorer* records are also available from deeper water in the outer firth during the period.

The remaining fish are from Inverness Firth (10,606), Spey Bay (21,000), Aberdour Bay (4,478) and the smaller bays along the south coast (5,485) taken in the *Enid–Kathleen* series.

The Inner Firth, 1910-1952

It will be seen from the *Goldseeker–Explorer* series that very definite size changes occurred during the period under review. From 1910 to 1930 a high size-structure characterised the stock in the comparatively shallow grounds of the Dornoch Firth, Nairn Bay and Burghead Bay. About half or more of the population consisted of marketable fish of from 25 cm to well over 60 cm. Of these from 13 to 25% were of 35 cm and over, while from 1 to 8% were larger fish of 45 cm and over. There is evidence during this period that an improvement resulted from the respite of the first war years, the data showing an increase of about 10% in marketable size-groups up to 35 cm and an increase of 5% in fish of 45 cm and over, while, even as late as 1926–30, the large and extra-large categories, 45 cm to over 60 cm, continued to be represented almost to the same degree as in 1910–14. It would seem, therefore, that for some ten years after its introduction to the Moray Firth in 1921 Danish seine-net fishing, whether prosecuted legally as in the outer firth or illegally as probably occurred to some extent within the 3 miles limit, had little or no effect on the size-composition of the plaice stock in these protected territorial waters.

From 1931, however, the picture changed pronouncedly. In 1931–35 the total marketable proportion fell to 20% (a third to one-half of any previous value) and practically all sizes over 35 cm ceased to be represented. A slight, almost negligible, increase in the over 35 cm size-groups seems to have occurred during World War II, but otherwise there has been no recovery from the drastic thinning which took place in the early 1930's. These inner firth areas have become typically 'small plaice' grounds, on which, by 1951-52, plaice of marketable size, not exceeding 37 cm, amounted to only 12% of the research vessel data. The parallel observations by *Kathleen* on these inner grounds in the later years, 1937-39 and 1946-52 (Fig. 5), as might be expected from the wider depth range within which they were taken, differ slightly from the other series, but nevertheless confirm the picture of a decline to a very low size-composition compared with earlier years.

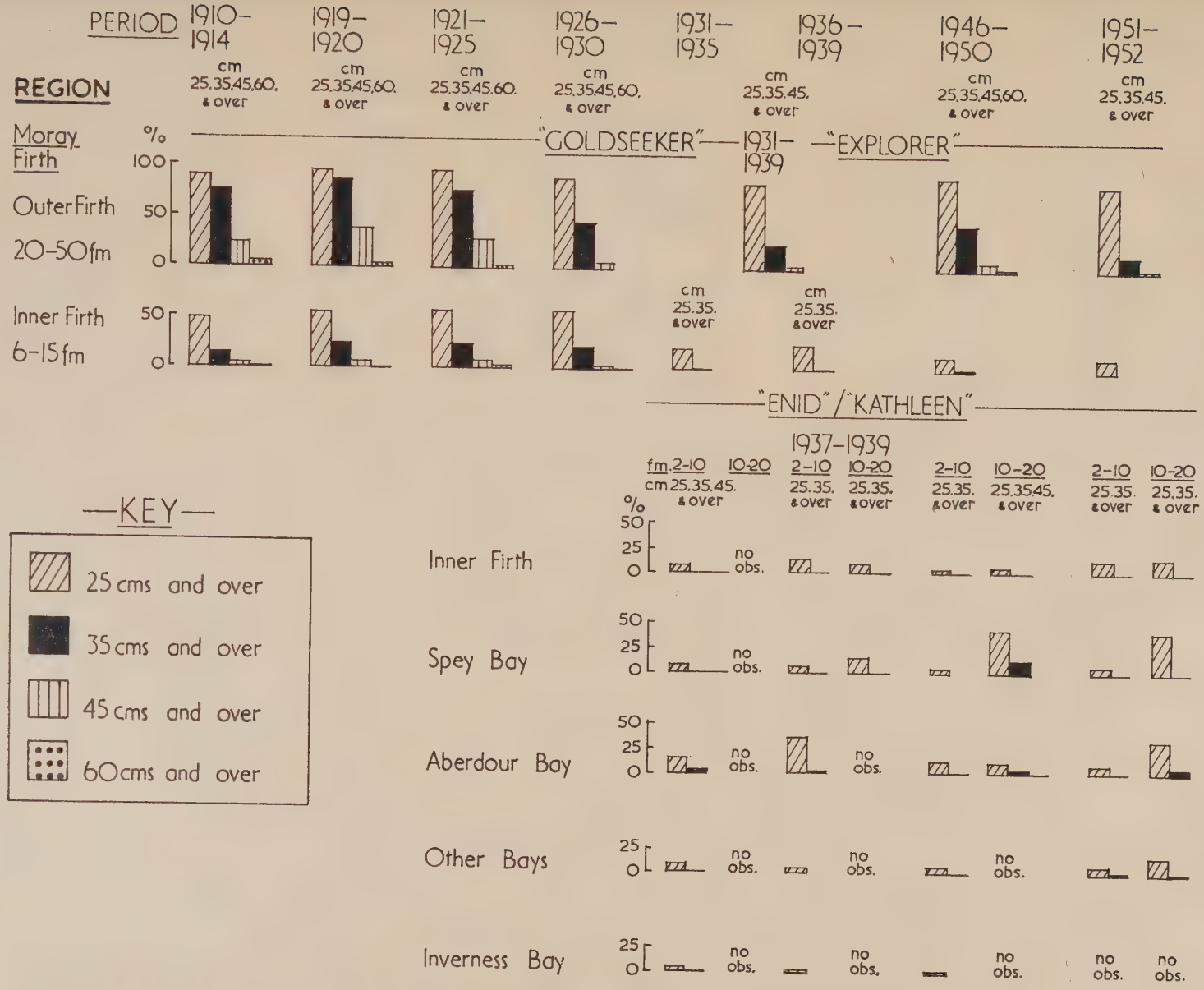

Figure 5. Plaice: Moray Firth, 1910-52. Size-composition; percentage at and over given sizes.

The Outer Firth, 1910-1952

The size-composition of plaice declined in the outer firth as well as in the protected waters of the inner firth. This is demonstrated in Figure 5, where it will be seen that the same phases of initially high and subsequently declining size-structure also occurred in the populations of much larger fish inhabiting the deeper water.

'Pruning' commenced some years earlier in the outer Firth (in 1926-30 as compared with 1931-35 on the inner grounds), where fishing is permitted, and there was a marked recovery there during World War II, though not in the inner Firth, but with these exceptions the same pattern is evident on the outer and inner grounds. The inner Firth population retained its high size-composition until 1930. Similarly the deeper water population remained at high size level until 1921-25, showing a similar slight recovery during World War I and remaining at the 1910-14 level during 1921-25.

From 1926 to 1939, however, although continuing to consist mainly of marketable fish, the size-structure of the stock declined markedly. Plaice of 35 cm and over fell from an average of 78% of the total in 1910-25 to 46% in 1926-30 and 24% in 1931-39, and fish of 45 cm and over declined from 29% to 6% and finally to 1% in the same period; plaice of 60 cm and over, which averaged 2·5% in 1910-25, disappeared entirely. The respite of World War II restored the stock to, and in the largest sizes improved upon, the level obtaining twenty years earlier in 1926-30, but by 1951-52 conditions had reverted to the pre-war II level with a tendency to still further deterioration.

The Smaller Bays of the Moray Firth, 1931-52

The *Enid–Kathleen* surveys of the smaller eastern bays, begun in 1931, disclose what might be expected following the conditions prevailing at the same depths of the inner firth at that time. Their plaice populations prior to 1931 are not known since no records are available. It is probable, however, that in the fully protected years before 1920, and perhaps even up to 1930, concentrations of medium and large plaice also existed in these smaller bays. At all events, the stocks reveal a general resemblance to those on the inner firth grounds during the later inshore survey period from 1931 onwards (Table II, Fig. 5). Like the inner firth grounds they are typical nursery areas in their shallowest parts where, with the exception of Aberdour Bay in 1937-39, only about 10% of the fish exceed 25 cm in length. In their deeper zones, from 10 to 20 fm, the plaice stocks of Spey and Aberdour Bays after the second war, although again as in the inner firth consisting predominantly of small fish, appear to have included relatively greater numbers of the bigger fish of at least 35 cm, Spey Bay having 11% at this size and over in 1946-50 and Aberdour Bay 6% as late as 1951-52.

Only brief comment need be made on the Inverness Firth. This subsidiary of the main firth is closed to seining and supports only a small, slow-growing population. Except for a small area near its entrance most of this firth is less than 5 fm deep. More than 95% of the plaice were under 25 cm long—a condition which persisted throughout the 1931-39 and 1946-50 periods (Fig. 5).

Rattray Head to Red Head

Thompson's and Garstang's investigations of the plaice stocks in this area were discontinued after 1910 so that no information is available about conditions immediately prior to the first war. As far as possible, however, their results are used to provide a comparison with investigations after 1918. These were mainly concentrated in Aberdeen Bay within the territorial limits, firstly, and somewhat irregularly, by *Goldseeker–Explorer* from 1919 to 1935 and, on a more intensive and regular scale by *Enid–Kathleen* from 1931 onwards. From the former, measurements of some 10,000 plaice are available, and in the latter surveys approximately 66,000. In addition, from 1921 to 1935 a number of observations were made by *Goldseeker–Explorer* within the territorial zone in 10-20 fm from Cove Bay to Gregness, immediately to the south of Aberdeen, in which more than 1,000 fish were caught. *Goldseeker–Explorer* records of plaice are also available for most years from 1921 to 1952 from offshore grounds beyond the 20 fm line; in all, these amount to the small total of 650 fish. These data, together with Thompson's and Garstang's earlier results are given in Table III and Figure 6.

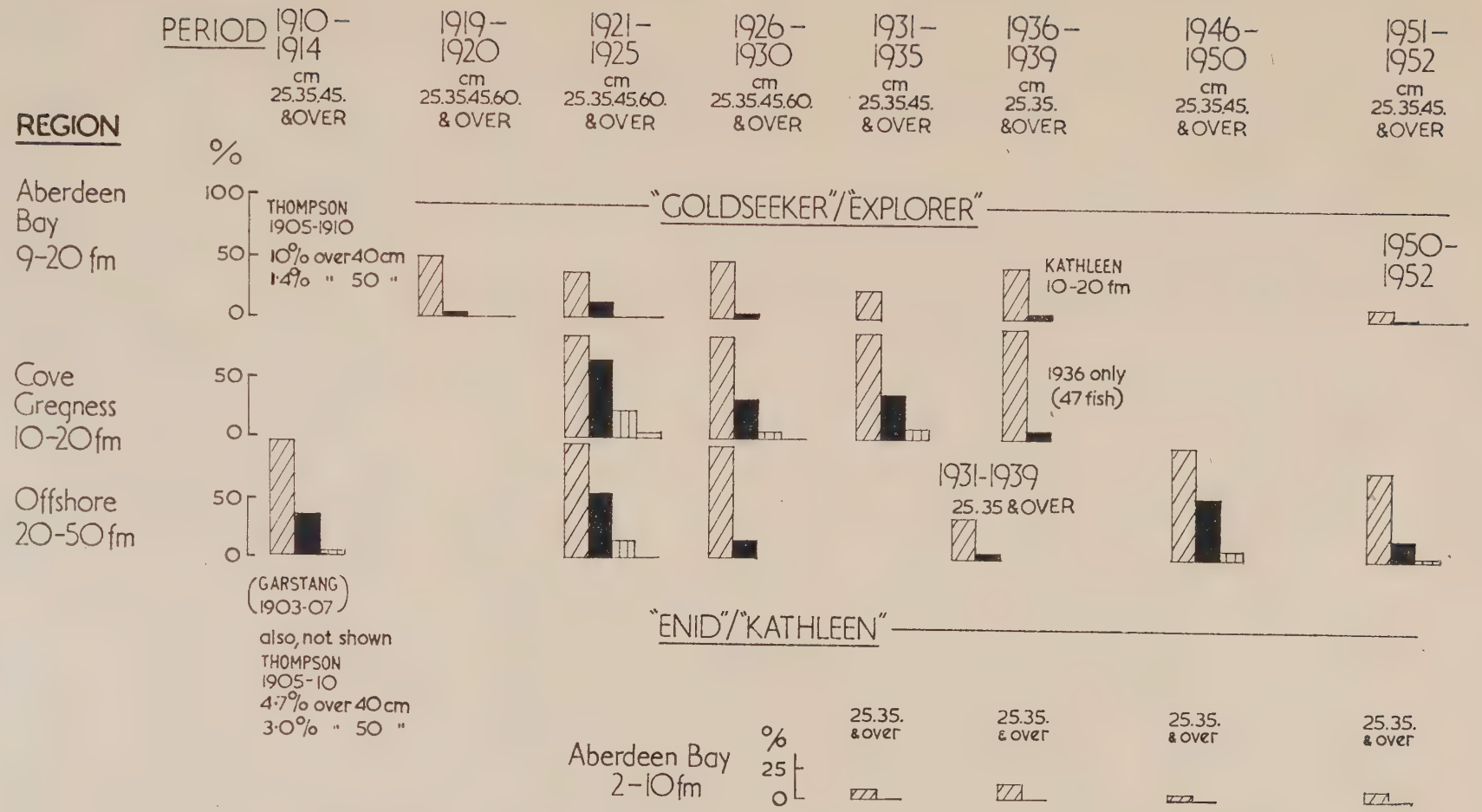

Fig. 6. Plaice: Rattray Head to Red Head, 1910-52. Size-composition; percentage at and over given sizes.

The Intra-territorial Zone

(*a*) Aberdeen Bay: Plaice stocks in Aberdeen Bay have never revealed the high size-composition which has characterised areas of similar depths in the Moray Firth and Firth of Forth, or even in Cove Bay, a few miles to the south. Although marketable sizes have at times approached 50% of the catches, and as late as 1939 amounted to 40%, plaice of 35 cm and over have been represented only by small numbers; very few fish of 60 cm and over have been caught there and these were taken prior to 1925. Sizes appear to have been at their largest before 1914, when, according to Thompson, 10% of the stock in the bay was over 40 cm and 1·4% over 50 cm. Except for the comparative absence of 60 cm fish these proportions compare favourably with the inner Moray Firth and Firth of Forth in the same period. In contrast to these latter areas, however, Aberdeen Bay surveys show a decline from 1919 to 1920 which was possibly associated with the opening of the bay to fishing in 1916-17. Despite an extension of the fishable area in the bay, the numbers of plaice of 35 cm and over and 45 cm and over increased in 1921-25, but the proportions were still less than the values for 1905-10. From 1926 to 1930, however, all plaice of 45 cm and over were eliminated from the bay and this was followed by the disappearance of fish of 35 cm and over in 1931-35, when marketable sizes formed only 25% of the total. The catches indicate some recovery in 1937-39 to size conditions comparable with those of 1926-30, but as sampling was not resumed at the deeper bay stations until 1950 it is impossible to say if this improvement was maintained during World War II and immediately afterwards. Results from offshore grounds in these years (Fig. 6) and the occasional presence of plaice of 45 cm and over in the bay in 1950-52 suggest that some recovery did occur, but observations in these latest years show that a period of low size-structure has again been reached.

(*b*) Cove-Gregness: The results from this sector of the coast are interesting in their striking dissimilarity to those from the same depths in the adjacent Aberdeen Bay. The first sampling in 1921-25 revealed an extremely high size-structure; 84% of the fish were of 25 cm and over, 61% of 35 cm and over, 22% 45 cm and over and 2% 60 cm and over; these proportions exceed even those of the offshore grounds and indeed any sector of the coast during these years except the outer Moray Firth. No data were available before 1921 but it seems reasonable to assume that this territorial locality was equally well-stocked with large plaice in the earlier, fully protected years. This sector, it will be recalled (p. 8), was opened to seining in 1921 and, as these results show, experienced the same thinning out of large fish as the years advanced, plaice of 60 cm and over disappearing from the catches after 1930 and those of 45 cm and over after 1935, while by 1936 less than 10% were 35 cm or over in length, although marketable sizes continued to comprise over 90% of the population. Unfortunately sampling on this ground was not resumed after World War II.

The Offshore Grounds (20–50 fm)

Since the introduction of trawling the offshore grounds of the Aberdeenshire coast have been more fully exploited by this method of fishing than those of the Moray Firth, where trawling by British vessels was prohibited by Act of Parliament in 1892. As may be expected this is reflected in a lower size-composition of the plaice on the former grounds. In 1903-07 95% of the plaice population on the Aberdeenshire coast offshore grounds were of marketable size, of which 34% were 35 cm and over and 2·4% 45 cm and over; no fish exceeded 60 cm in length (Garstang, 1909). In 1905-10, Thompson found 4·7% of the stock to be over 40 cm and 3·0% over 50 cm; plaice of over 60 cm were 'extremely scanty'. Apart from the fact, not unexpected considering the depths involved, that the plaice population on these grounds is almost entirely of marketable size, the proportions of the larger marketable size-groups are considerably below those of the Moray Firth, and also lower than in the protected waters of Aberdeen Bay in these early years.

Records are not available for 1919-20 but it seems clear from the 1921-25 catches that, as in almost all other areas, the respite from fishing during World War I resulted in a marked improvement in the quality of the plaice, including an appreciable increase in the numbers of fish of over 60 cm. Records also are rather few from 1926 to 1939 but there is little doubt that the stock suffered heavy attrition during

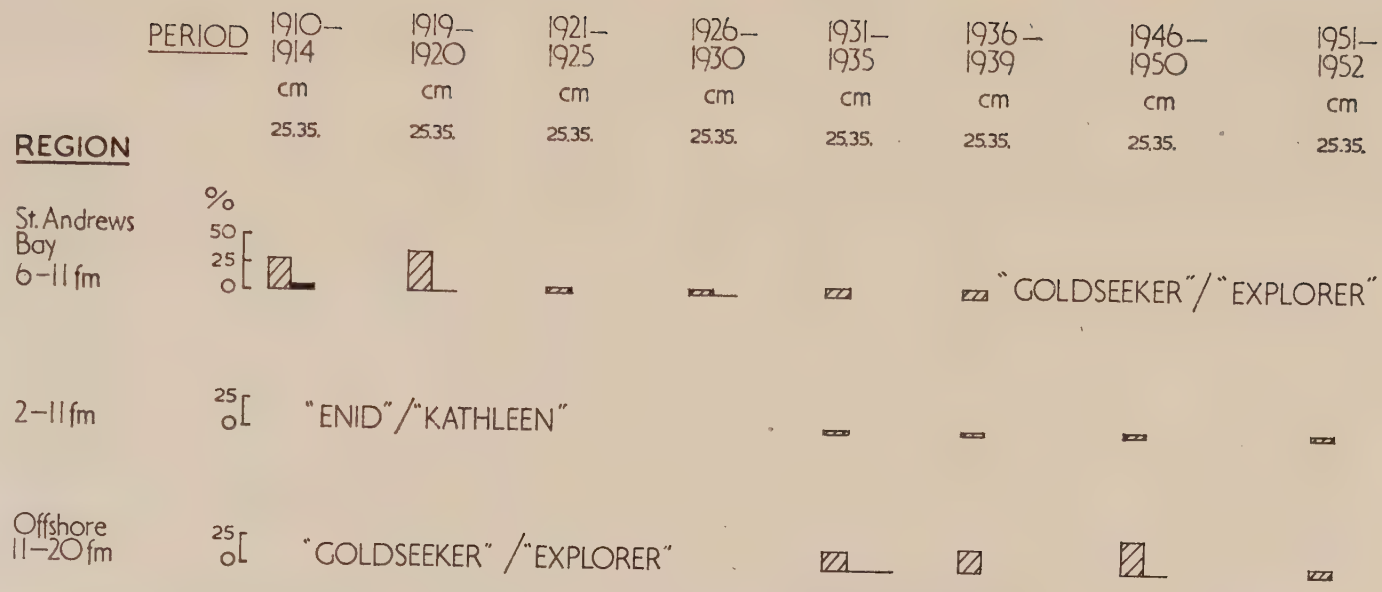

Fig. 7. Plaice: Red Head to Babbet Ness, 1910-52. Size-composition; percentage at and over given sizes.

these years, total marketable sizes declining by 1939, to 34%, 35 cm and over to less than 3%, and all fish in the 45 cm and over size-groups disappearing completely.

The situation after World War II, in 1946-50, is outstanding in showing a much higher size-structure, not only as compared with 1931-39 but also as compared with the period 30 years earlier (1903-07) 51% being of 35 cm and over and 8% 45 cm and over. These proportions are lower, but only by a small margin, than those of 1921-25 and fish of over 60 cm are no longer present, yet they are high and provide a further example of the resilience of plaice stocks under 'protected' conditions afforded by the limited fishing operations of the war years. As elsewhere, however, the effect of the return to full scale fishing was eventually experienced and the latest sampling, 1951-52, showed that stocks had again been thinned, although at that time the size-composition was still better than 20 years earlier, in 1926-30.

Red Head to Babbet Ness

This region is the most important nursery and 'small' plaice area in Scottish waters. It comprises, within territorial waters, the large nursery of St Andrew's Bay and the smaller, adjoining Carnoustie Bay, and, outside territorial waters, a wide extension seawards of grounds less than 20 fm deep suitable for small plaice. Observations were confined principally to St Andrew's Bay in depths under 20 fm. In the *Goldseeker–Explorer* series, only one, and occasionally two, stations, at depths of 6-11 fm, were worked up to 1931, when three 'fixed' stations were established to provide more representative sampling. The same stations were occupied when the *Enid* began operations in that year, together with an additional station in 2-3 fm. In 1931 also an 'outer' station in 15 fm was added to the *Explorer* surveys and, on the commissioning of *Kathleen* in 1937, two stations were added in 10-15 fm and 15-20 fm. As in the other regions, frequency of surveys varied within wide limits; most intensive sampling was carried out from 1931 to 1935.

Total plaice dealt with during the period from 1910 to 1952 was about 146,000; of this number *Goldseeker–Explorer* records account for 104,000 and *Enid–Kathleen* 42,000. The size-groupings are given in Table IV and Figure 7.

St Andrew's Bay differs from all the other regions, with the possible exception of the relatively unimportant Inverness Firth, in that it is predominantly a 'small-plaice' area. The bay itself is almost wholly a nursery area, while even in the adjacent offshore grounds most of the fish are below marketable size. Within the bay size-composition was at its best prior to 1921, but little difference has been observed between the periods immediately before and after World War I. Plaice of marketable size formed from 28 to 32% of the catch but the proportion of fish of 35 cm and over was small (less than 3%) and none was over 45 cm. Coinciding with the introduction and expansion of Danish seine-net fishing from 1921 onwards the size-composition of plaice in the bay was soon changed. Before the outbreak of the Second World War fewer than 5% of the plaice were of marketable size, most of them being less than 30 cm, and no evidence was obtained of any improvement in the size-structure of the stock as a result of World War II.

In data from the extra-territorial waters of the bay there are signs of a slight improvement in the size-composition of the fish immediately after the Second World War, but by 1951-52 this was no longer distinguishable from comparable figures for the bay itself.

Firth of Forth

Size data from this region (Table V, Figure 8) comprise continuous records from 1910 to 1952 at all depths from 10 to 26 fm. These were collected on the larger ships *Goldseeker* and *Explorer* from 1910 to 1935 and on *Kathleen* from 1937 to 1952. In addition, size data were also collected from the few shallower sandy bays within the 10 fm line on the *Enid* and *Kathleen* from 1931 onwards.

The numbers of plaice obtained were 18,631 from depths of 10 to 26 fm and 26,574 from 2 to 10 fm.

Depths 10–25 fm (1910–1952)

The results show that the fishery regulations had the effect of maintaining for many years a high degree of size-stability in this firth. Despite successive extensions of the area in which fishing was permitted

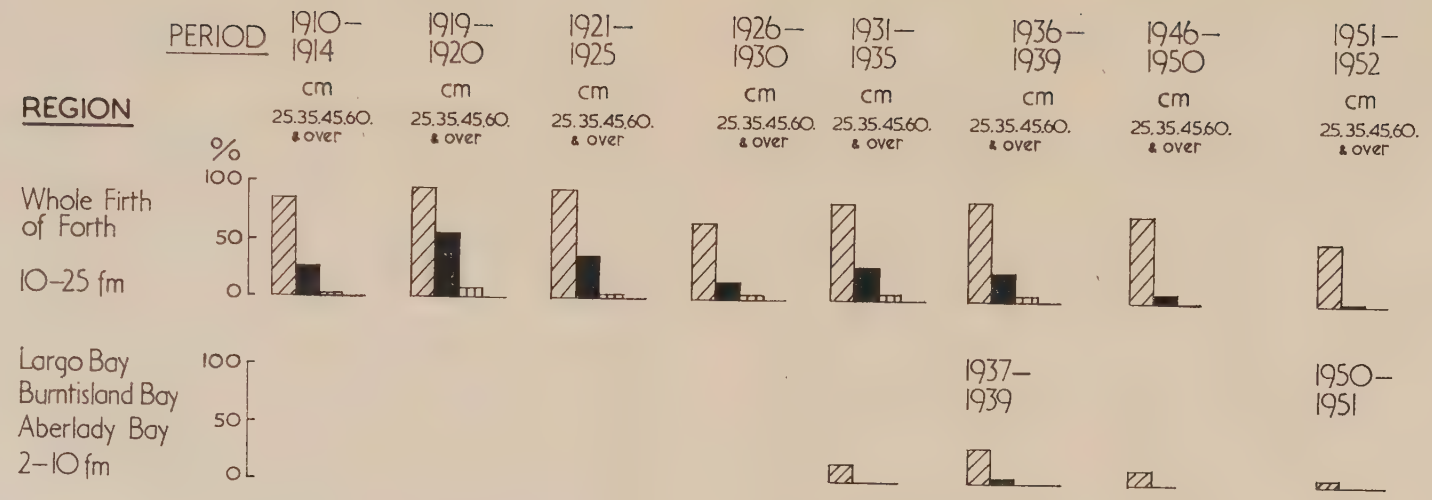

Fig. 8. Plaice: Firth of Forth, 1910-52. Size-composition; percentage at and over given sizes.

in 1914, 1916, 1929 and 1936, the stock in 1939 was still in the same satisfactory condition as in 1910-14. As in these early years, before the First World War, about 85% of the stock was of marketable size, of which 25% were 35 cm and above and 2% 45 cm and over, while small numbers of large plaice of 60 cm and over were also present. In the following twenty-five years there were fluctuations, notably an improvement after World War I which continued until 1925, and a decline in 1926-30 to below the pre-1914 levels. This was followed by a return to the 1910-14 conditions in 1931-39.

After World War II, however, in contrast to the improvement shown after World War I, the observations are in conformity not only with the absence of any rest and recovery during World War II but also with a deterioration in the size-structure to the lowest values for the period under review; marketable fish of 25 cm and over declined from 87% in 1937-39 to 76% in 1946-50 and to 52% in 1951-52, fish of 35 cm and over from 25% through 8% to 1%, and those over 45 cm from 2% to negligible numbers, while fish of over 60 cm were no longer represented in the firth. These effects were undoubtedly caused by the unrestricted fishing permitted in the firth and its approaches during the war years.

Depths of less than 10 fm (1931–52)

Sampling of the smaller and younger components of the population inhabiting the few sandy coastal stretches in the firth exhibits two features. In the first place, although these areas serve as nursery grounds, they nevertheless support a higher proportion of marketable-sized plaice (over 25 cm) than any other comparable nursery with the exception of the comparatively small Aberdour Bay in the Moray Firth (Table IV). Secondly, it is evident from the data that the increasing intensity and expansion of the fishery within the firth is reflected in changes in the stock of the shallower-water areas. Fish of marketable size show a significant representation up to 1939, including plaice over 45 cm and 60 cm, but after World War II these were reduced to the insignificant proportions characteristic of nursery conditions elsewhere.

CONCLUSIONS

These studies of the size-composition of plaice on Scottish east-coast grounds cover a period of more than forty years. Although the plaice is mainly a shallow-water fish the grounds on which the sampling was carried out vary both in depth and in the nature of the sea bottom. Moreover, the period under review was characterised by some marked changes in Scottish fisheries. Prior to the First World War trawling had succeeded in ousting line fishing as the principal method of catching white fish and, later, this in turn was to be challenged as a means of catching plaice by the introduction of the Danish seine. Accompanying the developments in the fisheries a series of regulative by-laws, was introduced, some of which were subsequently altered, thus affecting fishing on different sections of the coast.

Despite the varied nature of the grounds and the circumstances and regulations affecting the fisheries, some interesting results have emerged from this study of the size-composition of the plaice stocks. Foremost of all is the very marked reduction in the general size-composition of the fish on all grounds. This is most clearly demonstrated in the Moray Firth, from which more complete records are available than from any other locality. From an almost virgin plaice ground before the First World War, when large fish of up to 72 cm were commonly caught, the Moray Firth has now become so heavily fished that plaice of 60 cm or over are exceptional and fish of 45 cm and over are scarce.

It is clear too that the main reduction in the size of the plaice in the Moray Firth occurred during the 1920s concurrently with the expansion of the Danish seine-net fishery in that area.

On other east coast grounds a similar reduction in the size-composition of plaice is evident although the absence of data from before the first war leaves some doubt as to the condition of the stocks in some localities before the advent of the Danish seine. It seems likely, however, that both trawl and seine contributed to the reduction of the size-composition of the stocks outside territorial waters. Early records are available from the Firth of Forth comparable, to some extent, with those from the Moray Firth. In this area, too, the records show a marked reduction in the size-composition of the plaice with the complete disappearance of the very large fish and a scarcity of those over 45 cm in length.

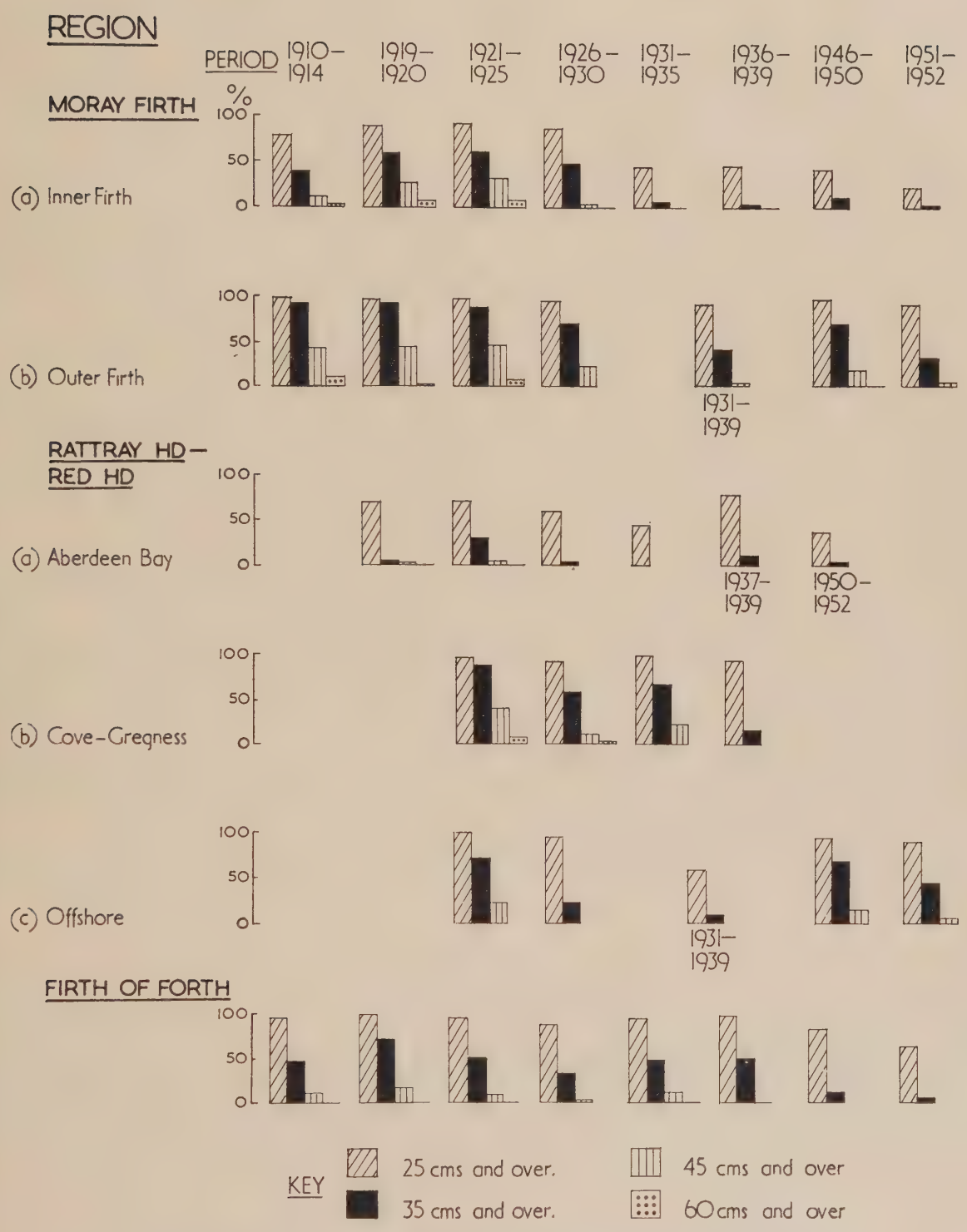

Fig. 9. Plaice: Weight of all plaice at and over certain sizes expressed as percentages of the total weight of all the fish caught.

Another feature which appears from these investigations is the remarkable power of recovery of the plaice stocks during the war periods, when fishing was severely restricted on the offshore grounds. As may be expected this resilience is most clearly observed in the outer Moray Firth and on other east coast grounds outside territorial waters.

The plaice grounds in the inner Moray Firth and in territorial waters generally are predominantly nursery grounds and, therefore, less likely to show changes in the size-composition of marketable fish. Nevertheless, some improvement was also observed here, particularly after the First World War. This improvement was much less obvious after the Second World War; in some localities no improvement was detected, while in the Firth of Forth the size-compositions of the plaice stocks actually deteriorated considerably. This undoubtedly was caused by the suspension of fishing restrictions in territorial waters and by the concentration of the small-boat fishery with seine nets in these waters during the second war.

The fluctuations in the size-composition of the plaice stocks over the period 1910 to 1952 obviously must have had a considerable effect on the nature of the landings by commercial vessels. Unfortunately fishery statistics during the period were not sufficiently detailed to permit a comparison of the origin and nature of commercial landings with research data. It is impossible, for example, to state whether commercial landings were greater or less at any particular time as a result of any general increase or decline in the size-composition of the stocks. Besides, there is some evidence that in the years when the seine-net fishery was expanding, and before the introduction of minimum marketable sizes, fishermen were more selective in their choice of fish for the market, and that later, with a growing scarcity of the bigger plaice, more reliance had to be put on smaller fish in order to obtain a satisfactory catch. It is clear, however, that as big fish were gradually reduced in numbers fishermen had to depend more on larger numbers of small fish.

Some indication of the extent of this change may be obtained from the conversion to weights of the numbers of fish caught at and above certain sizes. This conversion was based on observed average weights of plaice in each centimetre size-group. In Table VI (see Fig. 9) the resultant weights are represented as percentages of the total weight of fish of all sizes caught during research operations. While these percentages naturally demonstrate the greater weights of the bigger fish, they also emphasise, even more clearly than the percentages of the numbers of fish in each size-group, the change in the size-composition of the stocks over the years, and the increasing abundance of small plaice of just over the minimum marketable size in commercial supplies.

Although the elimination of big plaice from the stocks is to be regretted, it may be that their removal has resulted in more food being available for those that were left, and consequently in a rather better growth rate and an improvement in the condition of the smaller or younger fish. There is, however, little evidence of this in research records.

The author wishes to thank Dr Bennet B. Rae for his advice and assistance in the preparation of this paper.

SUMMARY

The size-composition of the plaice stocks on Scottish east-coast grounds from 1910 to 1952 has been studied. In the period under review changes have taken place in the nature and intensity of the Scottish fisheries and in the by-laws affecting fishing in territorial and other coastal areas. The overall effect of fishing on the plaice stocks has been to reduce considerably the numbers of the larger fish. In most localities the fishery is now chiefly dependent on the smaller marketable-sized plaice. Fluctuations in the size-composition of the stocks are noted in relation to the effect of the reduced fishing effort during the two wars.

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TABLE I

PLAICE LANDINGS IN SCOTLAND BY BRITISH VESSELS FROM ALL AREAS 1904-1961 IN CWT

Year	All methods	Trawl	Nets other than Trawl	Lines	Year	All methods	Trawl	Nets other than Trawl	Lines
1904	66836	53174	357	13305	1933	46846	17101	27094	2651
5	56249	45407	—	10842	34	63001	17521	42223	3257
6	58830	48951	2518	7361	1935	62602	15922	44028	2652
7	54700	43387	3047	8266	36	68743	19166	46773	2804
8	49412	37121	1888	10403	37	75891	21114	52488	2289
9	58977	45275	3223	10479	38	70396	22294	45801	2301
1910	51295	37728	3659	9908	39	54933	20746	32593	1594
11	53368	39158	5507	8703	1940	53019	10150	41612	1256
12	50238	35646	3431	11161	41	48551	8377	39194	976
13	43650	28294	4978	10378	42	59600	10065	48183	1348
14	52260	36265	6697	9298	43	53132	9808	41954	1370
1915	35485	19028	7182	9275	44	56322	10626	44709	987
16	43890	24231	7367	12292	1945	114318	59654	53834	830
17	43169	25248	8262	9659	46	123193	58316	64035	841
18	41630	26662	8535	6433	47	103283	35824	66489	970
19	68553	55740	6699	6114	48	84534	19766	64000	767
1920	92136	69749	16112	6275	49	96594	19500	76432	662
21	89001	47291	34154	7556	1950	88958	20600	68271	687
22	68658	33909	30700	4049	51	86630	20100	65977	553
23	50477	24863	22756	2858	52	88444	20100	67835	509
24	55730	21313	31562	2855	53	96641	24500	71561	580
1925	57173	24542	28408	4223	54	100296	24346	75454	496
26	60231	25384	30109	4738	1955	103715	23866	79273	576
27	56638	26857	25799	3982	56	102641	26617	75677	347
28	51727	25306	23020	3401	57	105325	25268	79785	272
29	57010	27965	25765	3280	58	104222	26548	77323	351
1930	55720	28400	24382	2938	59	120630	33359	97066	205
31	62409	23646	35344	3419	1960	114273	20079	93618	576
32	51897	21295	27295	3307	61	113348	21282	91434	487

TABLE II

SIZE-COMPOSITION OF PLAICE IN MORAY FIRTH, 1910-1952

NUMBERS OF FISH IN DIFFERENT SIZE-GROUPS EXPRESSED AS PERCENTAGES OF TOTALS

Period	Hours Fishing	Total Caught	Length Range (cm)	<25 cm	25 cm & over	35 cm & over	45 cm & over	60 cm & over
			Series 1. *Goldseeker—Explorer*					
			Dornoch Firth, Nairn Bay, Burghead Bay, 6–15 fm (11–27 m)					
1910–14	77½	16384	7–72	59·1	40·9	13·2	2·2	0·2
1919–20	32	2962	5–64	44·5	55·5	24·0	6·9	0·4
1921–25	117	8759	5–72	41·1	58·9	24·5	8·0	1·1
1926–30	37½	2032	8–69	40·4	59·6	20·6	1·2	0·1
1931–35	28	9149	6–59	79·7	20·3	0·7	—	—
1936–39	21	9841	6–40	76·0	24·0	0·3	—	—
1946–50	3½	683	11–42	86·5	13·5	1·5	—	—
1951–52	17	3003	11–37	88·4	11·6	+	—	—
			Outer Firth, 20–50 fm (37–92 m)					
1910–14	40	281	16–72	11·3	88·7	71·9	22·4	3·2
1919–20	108	1259	16–69	3·4	96·6	88·6	39·7	1·9
1921–25	180	2538	11–71	4·1	95·9	74·9	29·1	2·1
1926–30	56½	52	21–57	11·6	88·4	46·1	5·8	—
1931–39	136	152	15–49	15·1	84·9	23·7	1·3	—
1946–50	65	195	19–61	9·2	90·8	45·1	9·2	0·5
1951–52	103	885	15–53	19·4	81·6	14·1	1·6	—
			Series 2. *Enid—Kathleen*					
			Dornoch Firth, Nairn Bay, Burghead Bay, 2–10 fm (4–18 m)					
1931–35	110	24381	2–55	92·4	7·6	0·3	+	—
1937–39	44	12696	3–42	88·5	11·5	+	—	—
1946–50	54	23898	5–45	94·9	5·1	+	—	—
1951–52	22	9831	3–39	87·6	12·4	0·4	—	—
			Dornoch Firth, Nairn Bay, Burghead Bay, 10–20 fm (20–37 m)					
1937–39	32	6226	9–39	90·3	9·7	0·2	—	—
1946–50	56	19696	7–35	94·8	5·2	+	—	—
1951–52	23	7961	10–39	86·9	13·1	0·3	—	—
			Spey Bay, 2–10 fm (4–18 m)					
1931–35	41	5418	3–49	93·7	6·3	0·1	+	—
1937–39	18	4940	3–42	93·8	6·2	0·1	—	—
1946–50	12	6385	3–33	95·8	4·2	—	—	—
1951–52	6	1815	5–38	92·4	7·6	0·3	—	—
			Spey Bay, 10–20 fm (20–37 m)					
1937–39	10	959	10–43	84·5	15·5	0·8	—	—
1946–50	10	452	9–44	56·6	43·4	11·1	—	—
1951–52	6	1051	7–37	58·2	41·8	0·7	—	—
			Aberdour Bay, 2–10 fm (4–18 m)					
1931–35	22	1801	3–45	85·1	14·9	1·1	—	—
1937–39	6	108	3–35	62·0	38·0	0·9	—	—
1946–50	8	766	3–36	89·8	10·2	0·8	—	—
1951–52	6	954	6–39	90·8	9·2	0·6	—	—
			Aberdour Bay, 10–20 fm (20–37 m)					
1937–39	6	9	—	—	—	—	—	—
1946–50	8	571	5–49	89·7	10·3	1·0	0·2	—
1951–52	6	269	8–43	66·9	33·1	5·9	—	—
			Other Bays, 2–10 fm (4–18 m)					
1931–35	15½	1700	2–38	91·4	8·6	0·8	—	—
1937	1	220	5–32	95·9	4·1	—	—	—
1946–50	7	2916	4–37	93·0	7·0	0·5	—	—
1951–52	3½	494	5–44	92·9	7·1	1·0	—	—
			Other Bays, 10–20 fm (20–37 m)					
1951–52	1½	155	12–35	81·3	18·7	+	—	—
			Inverness Firth, 2–10 fm (4–18 m)					
1931–35	31	7779	3–40	96·8	3·2	+	—	—
1937–39	17	1806	5–28	98·7	1·3	—	—	—
1950	4	1021	7–28	98·3	1·7	—	—	—

TABLE III

SIZE-COMPOSITION OF PLAICE FROM RATTRAY HEAD TO RED HEAD, 1910-1952

NUMBERS OF FISH IN DIFFERENT SIZE-GROUPS EXPRESSED AS PERCENTAGES OF TOTALS

Period	Hours Fishing	Total Caught	Length Range (cm)	<25 cm	25 cm & over	35 cm & over	45 cm & over	60 cm & over
			Series 1. *Goldseeker—Explorer*					
			Aberdeen Bay, 9–20 fm (17–37 m)					
1905–10	(Thompson)	—	—		10% over 40 cm		1·4% over 50 cm	
1919–20	12	4553	10–64	50·5	49·5	1·2	0·2	+
1921–25	80	3014	5–67	62·7	37·3	10·3	0·7	+
1926–30	53	2002	14–44	54·3	45·7	1·4	—	—
1931–35	8	360	7–33	76·4	23·6	—	—	—
			Cove-Gregness, 10–20 fm (18–37 m)					
1921–25	15	563	14–72	16·4	83·6	61·3	22·2	2·1
1926–30	7	283	11–67	16·6	83·4	30·8	4·2	0·7
1931–35	7	167	16–54	11·4	88·6	37·7	7·8	—
1936	1	47	19–38	8·5	91·5	8·5	—	—
			Offshore—20–50 fm (37–92 m)					
1903–07	(Garstang)			5·5	94·5	33·5	2·4	—
1905–10	(Thompson)			4·7% over 40 cm		3% over 50 cm		
1919–20	no observations							
1921–25	33½	126	17–61	4·7	95·3	51·6	12·7	0·8
1926–30	8	71	21–40	7·1	92·9	14·1	—	—
1931–39	14	227	16–37	66·1	33·9	2·7	—	—
1946–50	30	122	16–55	6·6	93·4	50·8	8·2	—
1951–52	15½	111	17–58	24·3	75·4	18·0	2·7	—
			Series 2. *Enid—Kathleen*					
			Aberdeen Bay, 2–10 fm (4–18 m)					
1931–35	95½	17726	2–40	93·0	7·0	0·3	—	—
1937–39	30	5777	3–39	89·1	10·9	0·3	—	—
1946–50	24	6517	3–40	95·0	5·0	0·2	—	—
1951–52	52	26648	3–42	90·3	9·7	0·3	—	—
			Aberdeen Bay, 10–20 fm (20–37 m)					
1937–39	22	388	6–41	59·0	41·0	3·6	—	—
1950–52	64	8867	3–66	90·0	10·0	0·9	0·1	+

TABLE IV

SIZE-COMPOSITION OF PLAICE IN ST ANDREW'S BAY, 1910-1952

NUMBERS OF FISH IN DIFFERENT SIZE-GROUPS EXPRESSED AS PERCENTAGES OF TOTALS

Period	Hours Fishing	Total Caught	Length Range (cm)	<25 cm	25 cm & over	35 cm & over	45 cm & over
			Series 1. *Goldseeker—Explorer*				
			6–11 fm (11–20 m)				
1910–14	4	5246	10–42	72·3	27·7	2·1	—
1919–20	4	2344	7–38	67·6	32·4	0·3	—
1921–25	11½	28929	4–32	96·9	3·1	—	—
1926–30	41½	51662	5–35	97·3	2·7	+	—
1931–35	15	11430	6–36	94·9	5·1	—	—
1936–39	3	922	10–33	92·1	7·9	—	—
			11–20 fm (20–37 m)				
1931–35	9	3076	9–46	81·5	18·5	0·2	+
1936–39	1	154	13–30	81·2	18·8	—	—
			Series 2. *Enid—Kathleen*				
			2–11 fm (4–20 m)				
1931–35	42½	21848	3–31	97·8	2·2	—	—
1936–39	20	5291	6–32	97·2	2·8	—	—
1946–50	16	6444	3–31	97·9	2·1	—	—
1951–52	8	3223	6–33	95·3	4·7	—	—
			11–20 fm (20–37 m)				
1946–50	4	542	8–40	70·4	29·6	0·4	—
1951–52	4	4232	7–34	94·2	5·8	—	—

TABLE V

SIZE-COMPOSITION IN THE FIRTH OF FORTH, 1910-1952

NUMBERS OF FISH IN DIFFERENT SIZE-GROUPS EXPRESSED AS PERCENTAGES OF TOTAL

Period	Hours Fishing	Total Caught	Length Range (cm)	<25 cm	25 cm & over	35 cm & over	45 cm & over	60 cm & over
			The Whole Firth, 10–26 fm (20–46 m)					
			Series 1. *Goldseeker—Explorer,* 1910-1935					
			Series 2. *Kathleen,* 1937-1952					
1910–14	127	7368	11–65	13·5	86·5	25·3	2·7	0·1
1919–20	23	1440	11–66	3·6	96·4	55·3	8·1	0·4
1921–25	29½	1264	18–64	4·8	95·2	36·2	3·8	0·3
1926–30	56	5813	12–63	36·9	63·1	11·1	1·9	0·1
1931–35	45½	1192	12–66	17·9	82·1	25·8	3·4	0·3
1937–39	32	328	7–63	13·2	86·8	24·7	2·1	0·6
1946–50	30	228	12–53	24·1	75·9	7·9	0·9	—
1951–52	28¾	998	10–48	48·0	52·0	1·4	0·2	—
			The Bays, 2–10 fm (4–18 m)					
			Series 2. *Enid—Kathleen,* 1931-1952					
1931–35	63	16244	5–47	84·1	15·9	0·1	+	—
1937–39	31	2457	7–64	69·7	30·3	3·1	0·3	+
1946–50	27	3517	7–42	87·6	12·4	0·2	—	—
1951–52	17½	4356	6–48	94·8	5·2	0·1	+	—

TABLE VI

SCOTTISH EAST COAST, 1910-1952

WEIGHT OF ALL PLAICE AT AND OVER CERTAIN GIVEN SIZES EXPRESSED AS PERCENTAGES OF THE TOTAL WEIGHT OF ALL THE FISH CAUGHT

Period	25 cm & over	35 cm & over	45 cm & over	60 cm & over
Moray Firth				
(a) Inner Firth				
1910–14	79·1	43·2	13·8	2·6
1919–20	90·4	59·9	28·4	3·6
1921–25	91·3	63·3	35·1	7·7
1926–30	87·8	47·4	6·1	1·0
1931–35	45·2	3·8	0·3	0·0
1936–39	46·8	1·7	0·0	0·0
1946–50	45·1	13·0	0·0	0·0
1951–52	24·1	0·9	0·0	0·0
(b) Outer Firth				
1910–14	98·2	91·6	43·7	8·9
1919–20	99·8	96·7	47·5	3·4
1921–25	99·5	91·1	47·3	4·9
1926–30	96·5	70·9	24·6	0·0
1931–35	96·8	44·5	0·0	0·0
1936–39	92·3	38·7	6·5	0·0
1946–50	98·2	70·1	19·9	2·5
1951–52	93·3	32·5	6·0	0·0

Period	25 cm & over	35 cm & over	45 cm & over	60 cm & over
Rattray Head—Red Head				
(a) Aberdeen Bay				
1919–20	71·1	4·6	1·2	0·3
1921–25	73·1	32·6	3·9	0·5
1926–30	64·9	5·9	0·0	0·0
1931–35	45·9	0·0	0·0	0·0
1937–39	82·0	13·5	0·0	0·0
1950–52	37·0	2·4	0·0	0·0
(b) Cove-Gregness				
1921–25	97·3	86·2	41·2	6·3
1926–30	95·0	57·0	13·7	2·4
1931–35	98·1	66·6	21·7	0·0
1936–39	96·3	15·6	0·0	0·0
(c) Offshore				
1921–25	99·2	75·1	28·6	3·3
1926–30	97·2	21·9	0·0	0·0
1931–39	59·2	9·1	0·0	0·0
1946–50	98·7	70·7	18·9	0·0
1951–52	91·3	48·3	8·8	0·0
Firth of Forth				
1910–14	96·2	47·6	13·4	0·7
1919–20	99·2	74·5	17·9	1·7
1921–25	98·6	51·3	9·3	1·3
1926–30	84·6	30·7	9·1	0·5
1931–35	94·3	48·6	11·9	1·3
1936–39	96·4	46·0	3·0	0·0
1946–50	83·9	12·4	0·0	0·0
1951–52	66·6	3·0	0·0	0·0

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